HARGIS + ASSOCIATES, INC.

SITE-WIDE GROUNDWATER

REMEDIAL ALTERNATIVES STUDY WORK PLAN

FORMER MONTROSE AND STAUFFER FACILITIES AREA

HENDERSON, NEVADA

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ACRONYMS AND ABBREVIATIONS

ACD	Agricultural Chemicals Division
ARARs	Applicable or Relevant Requirements
BHC	Benzene hexachloride
CPA	Closed Ponds Area
CSM	Conceptual Site Model
DNAPL	Dense-Non Aqueous Phase Liquid
EPA	U.S. Environmental Protection Agency
Groundwater RAS	Groundwater Remedial Alternatives
GWTS	Groundwater treatment system
H+A	Hargis + Associates, Inc.
HCL/BCME	Hydrochloric Acid/Bischloromethylether
LOU	Letter of Understanding
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
Montrose	Montrose Chemical Corporation of California
NAC	Nevada Administration Code
NCP	National Contingency Plan
NDEP	Nevada Division of Environmental Protection
PES	PES Environmental, Inc.
RAOs	Remedial Action Objectives
SOPs	Standard operating procedures
SRCs	Site-related chemicals
Syngenta	Syngenta Crop Protection, Inc.
TDS	Total dissolved solids
the Companies	Montrose, SMC/Syngenta, and Olin Chlor-Alkali Corporation
Tronox	Tronox, LLC
UIC	Underground Injection Control
UMCc	Coarse-grained Upper Muddy Creek Formation
UMCf	Fine-grained Upper Muddy Creek Formation
VOCs	Volatile organic compounds

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1.0 INTRODUCTION

On behalf of Montrose Chemical Corporation of California (Montrose), Stauffer Management Company, LLC/Syngenta Crop Protection, Inc. (SMC/Syngenta), and Olin Chlor-Alkali Corporation, Inc. (Olin) (collectively designated as the Companies), Hargis + Associates, Inc. (H+A) is submitting this work plan for a site-wide Groundwater Remedial Alternatives Study (Groundwater RAS) to be conducted at the former Montrose and Stauffer facilities (Figure 1). A Groundwater RAS work plan was requested by the Nevada Division of Environmental Protection (NDEP) in a letter to the Companies dated April 14, 2008 (NDEP, 2008b). A Groundwater RAS work plan fulfills a requirement stated in the Consent Agreements between the Companies and NDEP (NDEP, 1996a and 1996b).

2.0 WORK PLAN OBJECTIVES

This work plan has been developed as a general planning document to initiate the Groundwater RAS process in general accordance with an outline for RAS documents provided to the Companies by NDEP (NDEP, 2008c). The objectives of the work plan include:

- Define the scope of the Groundwater RAS;
- Summarize the activities planned to resolve existing data gaps (including those presented in related documents);
- Outline the framework of the Groundwater RAS and identify relevant guidance documents;
- Identify potential remedial technologies and alternatives to address impacted groundwater and non-aqueous phase liquids (NAPLs), and
- Provide a proposed schedule for completing the Groundwater RAS.

3.0 ONGOING WORK RELATED TO THE GROUNDWATER REMEDIAL ALTERNATIVES STUDY

The following sections briefly summarize the scope and status of various Montrose and Stauffer site investigations related to the development of the Groundwater RAS.

3.1 RELATED SITE REMEDIAL ALTERNATIVES STUDY WORKPLANS

Draft RAS workplans for the Montrose site assessment areas and Stauffer site Letter of Understanding (LOU) item areas have previously been submitted to NDEP for review and comment. These workplans, currently in various stages of development, collectively address the potential source areas for impacted groundwater.

The following RAS workplans for the Montrose site assessment areas have been submitted to NDEP:

- Montrose Former Plant Site soil (H+A, 2008e);
- Montrose Former Tank Farm Area soil (H+A, 2008d);
- Montrose Former Benzene Storage Tank Area soil (H+A, 2008c), and
- Montrose Closed Ponds Area (Geosyntec Consultants, 2008).
    - This workplan initially focused on groundwater issues specific to the Closed Pond Area to develop a field investigation workplan but is currently being revised to address source area evaluation more directly while transferring groundwater related subjects to the groundwater RAS.

The following RAS workplans for the former Stauffer LOU item areas, which included evaluations for both impacted soil and groundwater, have been submitted to NDEP:

- Stauffer benzene hexachloride (BHC) Cake Pile 3, Agricultural Chemicals Division (ACD) Drum Burial Waste Management Area, and Former Leach Beds and Phosphoric Pond and Trenches (PES Environmental, Inc. [PES], 2008a);
- Stauffer Former ACD Plant, Former Lindane Plant, Former BHC Cake Piles 1 and 2 and Former BHC Loader Haul Route (PES, 2008b), and

- Stauffer Former Wastewater Ponds 1 and 2, Former Cell Renewal Building Area and Associated Conveyance Facilities, Inactive CAPD Pond 6, Inactive CAPD Pond 7, and Inactive CAPD Pond 8 (PES, 2008d).

These facility-specific RASs primarily address impacted soil, while the evaluation of remedial alternatives for groundwater, as covered by this workplan, will be covered in the site-wide Groundwater RAS. Relevant information and results from the area-specific RASs will be incorporated into the Groundwater RAS.

3.2 AREA-SPECIFIC CONCEPTUAL SITE MODELS AND DATA GAP EVALUATIONS

This section briefly discusses data gaps identified in additional area-specific studies that were performed by Stauffer and Montrose after the completion of the site-wide conceptual site model (CSM).

3.2.1 Former Stauffer Facility

Area-specific CSMs were developed by SMC/Syngenta for the BHC Cake Pile 3, Former ACD Drum Burial Waste Management Area, Former Leach Field, Phosphoric Pond, and Trenches, Inactive ACD Ponds 1 and 2, and the Hydrochloric Acid/Bischloromethylether (HCL/BCME) Release Area (PES, 2008c). As part of the area-specific CSM development, groundwater data gaps were identified and sampling and analysis plans were prepared to address the data gaps.

3.2.2 Former Montrose Facility

A focused CSM was developed and a preliminary screening of groundwater remedial alternatives was performed for the Montrose Closed Ponds Area (CPA) (Geosyntec Consultants, 2008). This study evaluated eleven potentially applicable remedial technologies. Based on this evaluation, four potential remedial alternatives were developed for the CPA including no action; monitored natural attenuation (MNA); pump, treat, and recirculation with Perozone® treatment and MNA; and barrier wall/in-situ treatment with modified Fenton's

Reagent, and MNA. The no action alternative was eliminated because an engineered cap has already been installed, institutional controls (fencing) are in place, and deed restrictions have been recorded. The preliminary evaluation of the remaining three alternatives did not indicate a preferred remedial alternative due, in part, to the existence of data gaps associated with the characterization near the CPA. The data gaps are discussed in Section 5.0 and additional investigation is currently underway. This preliminary evaluation of groundwater remedial alternatives related to the Montrose closed ponds will be incorporated into the site-wide groundwater RAS process to provide a unified evaluation of groundwater alternatives across the site.

4.0 SCOPE OF GROUNDWATER REMEDIAL ALTERNATIVES STUDY

The Groundwater RAS will develop and evaluate alternatives for the remediation of contaminants (both dissolved and non-aqueous phase) as appropriate based on cleanup goals which will be established during the RAS process.

4.1 RISK ASSESSMENT

At the former Stauffer site, a risk assessment is pending to evaluate potential exposures to site-related chemicals (SRCs) in surface soil outside paved areas, and in subsurface soil encountered during excavation work. The risk assessment will also evaluate the effect of volatile organic SRCs in shallow groundwater on surface environments and assess potential exposure via vapor diffusion through vadose zone soil (Integral, 2008).

At the Montrose site, similar risk assessment activities are being planned for the former plant site and former tank farm areas. The results of the risk assessment may be used to establish risk-based cleanup goals for the site.

4.2 CHEMICALS OF INTEREST

Extensive analyses were performed during the development of the draft site-wide CSM to characterize the nature and extent SRC-impacted groundwater at the site (H+A, 2007b). As discussed in detail in the draft CSM report, the groundwater at the site is impacted by a variety of chemical types including volatile organic compounds ([VOCs]; primarily benzene, chlorobenzene, 1,2- and 1,4-dichlorobenzene, and chloroform), organochlorine pesticides, organic acids, arsenic, and TDS. Remedial alternatives will be developed and evaluated in the Groundwater RAS to address groundwater impacted by these chemical types to the extent required to meet cleanup goals.

4.3 AREA OF INTEREST

The development and detailed evaluation of remedial alternatives in the Groundwater RAS will be performed within the geographic area nominally bounded on the south by Lake Mead Boulevard, on the north by Warm Spring Road, on the west by the Olin property boundary, and on the east by the extent of dissolved-phase organic groundwater contamination on the western portion of the Tronox, LLC (Tronox) facility (Figure 1). For purposes of planning the RAS process, this area is designated as the "RAS area" and, based on current knowledge, contains the source areas that have potentially impacted groundwater and the groundwater treatment system (GWTS).

The RAS area was also established based on the distribution of contaminants in the groundwater. The following key observations support establishing the proposed RAS area:

- Based on detailed evaluations performed in the site-wide CSM, the majority of dissolved contaminant mass in the groundwater exists south of the GWTS. The nature and extent of this contamination is well characterized based on extensive groundwater quality data. Additional characterization work is planned to confirm the extent of impacted groundwater along the eastern margin of the plume (see Section 5.0).
- The significant reduction in contaminant mass that occurs across the GWTS area is evidence that the GWTS has been historically effective at controlling most of the northward migration of contaminants.

Therefore, the focus of the Groundwater RAS will be on remedial alternatives to address the groundwater contamination that exists south of the GWTS because most of the impacted groundwater lies in this area and the GWTS is largely effective at controlling the off-site migration of contaminants in the groundwater.

Residual impacted groundwater does exist north of the GWTS primarily in the alluvial aquifer. However, the mass of contaminants and extent of their concentrations greater than the MCLs in groundwater are small compared to the area south of the GWTS and appear to originate, in part, from off-site areas which are the responsibility of others. Therefore, given the historical effectiveness of the GWTS at preventing off-site contaminant migration from the former Stauffer and Montrose sites and the limited mass of contaminants in the area downgradient of the

GWTS, active remediation is not envisioned to address impacted groundwater north of Warm Springs Road. Monitored natural attenuation is considered to be the primary candidate remedial alternative to address the impacted groundwater in the area downgradient of the GWTS. Therefore, evaluation of active remedial alternatives for the area downgradient of the GWTS is not planned for the Groundwater RAS.

4.4 HYDROGEOLOGIC UNITS

The two primary lithostratigraphic units that comprise the groundwater system in the RAS area include the Quaternary Alluvium (Qal) fan deposits and the underlying Muddy Creek Formation. The Qal fan deposits typically consist of sands, gravels, and cobbles with varying amounts of silts and clay. The underlying Muddy Creek Formation consists of clays and silts with lesser and varying amounts of fine-grained sand and gravels.

Drilling in 2006 to the present indicates the presence of a reworked or “transition zone” of fine-grained sediments near the base of the Qal deposits. These fine-grained sediments are interpreted as reworked sediments (primarily clays and silts) from the underlying finer-grained Upper Muddy Creek Formation that have been redeposited within coarser-grained sediments and caliche at the base of the Qal. The transition zone exhibits characteristics of both the Qal and upper portions of the Muddy Creek Formation.

The Muddy Creek Formation is comprised of basin-fill sediments deposited in an alluvial system. The sediments are generally coarser-grained near the mountain fronts and grade to progressively finer-grained deposits near the center of the valley. Beneath the investigated areas of the Site to a depth of about 275 feet, the Muddy Creek Formation consists principally of clays and silts interbedded with thin, sporadic deposits of fine- to medium-grained sand or mixtures of clayey, silty sand. These sporadic interbeds range in thickness from one to three feet. Between approximately 275 and 300 feet bgs a coarser-grained interval or facies of the Muddy Creek Formation has been identified beneath the RAS area and the adjacent Tronox facility.

Groundwater is present within the Qal deposits and Muddy Creek Formation in the RAS area. Groundwater is first encountered within saturated sediments near the base of the Qal deposits, in the transition zone between the Qal deposits and underlying Muddy Creek Formation, or in the uppermost portions of the underlying Muddy Creek Formation, and is referred to as the alluvial aquifer. The alluvial aquifer typically occurs under unconfined conditions and is only a few feet thick in the southern portion of the RAS area, increasing in thickness and generally becoming coarser-grained to the north in the area of the GWTS.

Underlying the alluvial aquifer is the fine-grained Upper Muddy Creek formation (UMCf) (previously referred in some documents as the “second water-bearing zone”). In the RAS area, the UMCf consists predominantly of unconsolidated to semi-consolidated silt and clay, with occasional interbeds of fine- to medium-grained sand with silt and gravels. These interbeds are typically between one and three feet thick and appear to be discontinuous throughout the formation, as they are encountered at varying depths in boring to boring. Caliche is present, typically near the contact between the alluvial aquifer and the Upper Muddy Creek Formation and in the transition zone. The UMCf typically occurs under semi- confined to confined conditions.

The deepest hydrogeologic unit in the RAS area is the coarse-grained Upper Muddy Creek formation (UMCc) (previously referred to in some documents as the “third water-bearing zone”). A review of lithologic logs indicates that the UMCc is generally composed of well-graded sand and clayey sand at depths ranging from approximately 275 to 300 feet bgs. Groundwater in the UMCc occurs under confined conditions.

Remedial alternatives will be developed and evaluated to address impacted groundwater in the alluvial aquifer and the UMCf within the RAS area. Impacted groundwater has not persisted in the UMCc; therefore, remediation of the UMCc is not required and remedial alternatives will not be developed and evaluated for the UMCc in the Groundwater RAS.

4.5 DENSE NON-AQUEOUS PHASE LIQUID RESPONSE ACTIONS

One of the primary emphases of the Groundwater RAS will be to develop and evaluate response actions to address the DNAPL impacted zone. The Groundwater RAS will include identification and screening of remedial technologies that would reduce the mass of DNAPL (e.g., excavation, in-situ thermal treatment, etc.) or implement control technologies. However, it is fully expected that reduction-in-mass remedial technologies will be eliminated during the screening process on the basis of poor effectiveness, difficult implementation, and high cost. The evaluation of potential response actions for the DNAPL will therefore focus on hydraulic containment with the existing GWTS and possible enhancements to improve hydraulic isolation of DNAPL.

5.0 RESOLUTION OF DATA GAPS

Completion of the Groundwater RAS requires a reasonably complete understanding of the site hydrogeologic conditions and the nature, extent and migration pathway of contaminants in the groundwater. Although groundwater investigation work is currently ongoing, as demonstrated by the work being performed at the Montrose Closed Ponds Area and work planned by Stauffer in the vicinity of their LOU item areas, the majority of site characterization was completed during hydrogeologic investigations conducted previously at the site. However, data gaps exist at the site as discussed in the draft CSM and subsequent studies performed by Montrose and Stauffer (H+A, 2007b, Geosyntec 2008, and PES, 2008c). Existing data gaps are briefly summarized below along with the proposed approach for their resolution.

5.1 EXTENT OF NON-AQUEOUS PHASE LIQUIDS

Additional investigations were conducted in May 2008 to further characterize the nature and extent of DNAPL in groundwater at the site (Figure 2) (H+A, 2007b). This additional characterization was needed to develop an understanding of the nature, extent, migration potential of the DNAPL as a persistent source of dissolved-phase chemicals to the alluvial aquifer and UMCf groundwater. Findings of the investigation will be summarized in a report to NDEP tentatively scheduled for submittal in late July 2008.

In addition, Stauffer has prepared workplans to address the issue of NAPLs in the former facility area. The results of these investigations will be incorporated into the groundwater RAS.

The Companies are jointly conducted quarterly groundwater monitoring within the RAS area and beyond. Monitor wells located throughout the RAS area are monitored for the presence of both light non-aqueous phase liquid (LNAPL) and DNAPL. The ongoing results of this program will be incorporated into the groundwater RAS.

5.2 MONTROSE CLOSED POND AREA

Previous investigations identified the CPA as a source of SRCs to the groundwater (Figure 2). A draft focused CSM and preliminary RAS for the CPA identified the need for additional characterization of the alluvial aquifer in the vicinity of the CPA (Geosyntec, 2008). NDEP concurred in a subsequent comment letter (NDEP, 2008a). Montrose has proceeded with the additional site characterization at the CPA, which includes the drilling of exploratory borings, installation of up to five additional monitor wells screened in near the contact between the alluvial aquifer and Upper Muddy Creek formation (one upgradient and four downgradient of the CPA) and aquifer testing to characterize the hydraulic properties of the principle transport zones in the vicinity of the CPA. The new wells and testing will be used to further define the groundwater flow direction, hydraulic gradient, and contaminant distribution in the vicinity of the CPA and incorporated into the groundwater RAS.

5.3 EASTERN EXTENT OF ORGANIC GROUNDWATER CONTAMINATION

The lateral and vertical extents of dissolved-phase VOCs in groundwater are not fully known along the eastern boundary of the Olin property and in the western portion of the Tronox property (Figure 2).

Characterization of the eastern extent of the VOC plume will be completed by a combination of 1) analytical data collected during the May 2008 DNAPL investigation, 2) the results of the groundwater investigation segment of the joint vapor intrusion investigation and 3) the Tronox Phase B source area investigation being conducted along the western portion of the Tronox property (ENSR, 2008).

5.4 EXTENT OF IMPACTED GROUNDWATER IN VICINITY OF FORMER STAUFFER WASTE MANAGEMENT AREAS

Area-specific CSMs were developed for selected Stauffer waste management areas (Section 3.2.1) (PES, 2008c). Based on the findings of these focused CSMs, SMC/Syngenta will install and sample three additional monitor wells in the vicinity of the former waste management areas identified above. Two alluvial aquifer monitor wells are to be installed downgradient of the Former ACD Drum Burial Waste Management Area and one UMCf monitor well is planned downgradient of the combined waste management areas.

5.5 CAPTURE EFFECTIVENESS OF GROUNDWATER TREATMENT SYSTEM

The effectiveness of the existing GWTS to capture alluvial aquifer groundwater containing SRCs is not fully evaluated. A work plan was submitted to NDEP that outlined the installation of additional piezometers within the extraction wellfield to further characterize water level conditions and evaluate the extent to which the cones of depression created by the extraction wells overlap (H+A, 2008a). Water level data from the new and existing monitor wells, piezometers, and extraction wells will be evaluated to develop multiple lines of evidence that demonstrate capture in accordance with recent EPA guidance (EPA, 2008).

One new extraction well and one replacement extraction well are being installed at the GWTS. The new extraction well will be located in the central portion of the wellfield in an area where capture and overlapping cones of depression are uncertain (H+A, 2007a). The replacement extraction well will be installed in the easternmost portion of the wellfield to replace an existing extraction well that has exhibited declining productivity. The replacement extraction well is expected to increase the groundwater production in the easternmost portion of the wellfield and improve the capture effectiveness of the entire GWTS.

5.6 SITE-RELATED CHEMICALS IN THE MUDDY CREEK FORMATION AT THE GROUNDWATER TREATMENT SYSTEM

The presence of dissolved-phase SRCs in the UMCf in the immediate vicinity of the GWTS and the effectiveness of the GWTS to potentially capture these SRCs, if present, is unknown. Additional investigation is needed to determine if SRCs are present above regulatory standards in the UMCf groundwater and to define the hydraulic relationship between the alluvial aquifer and the UMCf relative to the operation of the GWTS. These data gaps will be resolved by installing three monitor wells screened in approximately the upper 20 to 30 feet of the UMCf on the downgradient (north) side of the GWTS extraction well field (H+A, 2007c).

The investigations discussed above depend on obtaining access to properties owned or controlled by entities other than the Companies. As of the submittal date of this work plan, the Companies are working with the property owners to obtain property access.

5.7 UPWARD VERTICAL MIGRATION OF GROUNDWATER

Upward migration of impacted groundwater from the UMCf to the alluvial aquifer in the area upgradient of the GWTS exists, however, is not well understood across the site and in particular along the direction of regional groundwater flow. Water levels measured in site monitor wells indicate an upward hydraulic gradient from the UMCf to the alluvial aquifer across most of the site. However, insufficient water level and water quality data exist to fully understand the nature and extent of the upward movement of impacted groundwater.

This concept is important for fully assessing the potential impact of the DNAPL as a long-term source of dissolved-phase contamination in the groundwater and whether the existing GWTS is effective at containing these dissolved-phase SRCs. Presently, it is believed that groundwater within the Muddy Creek Formation, impacted by contact with DNAPL materials, is transported upward into the overlying alluvial aquifer and discharges in areas upgradient of the GWTS. The GWTS then extracts and treats those organic contaminants downgradient of these discharge areas. Additional investigation work is being planned to further evaluate and potentially confirm this concept.

5.8 UNDERGROUND INJECTION CONTROL PERMIT

Additional information on the requirements of a future Underground Injection Control (UIC) Permit is needed to fully complete the Groundwater RAS. Specifically, an understanding of future chemical concentration discharge limits for the GWTS will be required to evaluate the effectiveness of the GWTS as a permanent remedial action. The Companies will require information from NDEP on the UIC Permit requirements to avoid delays in the Groundwater RAS process.

6.0 GROUNDWATER REMEDIAL ALTERNATIVES STUDY PROCESS

The Groundwater RAS process will be completed in accordance with the U.S. Environmental Protection Agency (EPA) *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988). The process envisioned for completing the Groundwater RAS includes the following three primary sequential components:

- Component 1 - Resolution of Data Gaps – resolution of data gaps as outlined above is required to fully delineate the extent and migration pathway(s) of impacted groundwater (both dissolved-phase and DNAPL) and further evaluate the capture effectiveness of the GWTS. The Companies plan to resolve these data gaps to the extent possible before initiating any detailed evaluation of remedial alternatives in the Groundwater RAS process (Component 3).

- Component 2 – Preliminary Development and Screening of Remedial Technologies and Alternatives – during this activity, the following will be accomplished:
    a. Establish Remedial Action Objectives (RAOs);
    b. Identify Applicable or Relevant Requirements (ARARs);
    c. Develop General Response Actions;
    d. Identify and Screen Appropriate Technologies;
    e. Select Representative Process Options;
    f. Reevaluate Data Needs;
    g. Assemble Technologies into Alternatives;
    h. Screen Alternatives, if Required, and
    i. Prepare Screening Report.

The purpose of the screening report is to focus the subsequent detailed evaluation of remedial alternatives. The Companies envision that the preliminary development and screening of remedial technologies and alternatives will be performed in conjunction with the resolution of data gaps.

- Component 3 - Detailed Evaluation of Remedial Alternatives – detailed individual and comparative evaluation of retained remedial alternatives from the screening process will be performed against the following nine criteria:
    a. Threshold Criteria
        i. Overall protection of human health and the environment
        ii. Compliance with ARARs
    b. Primary Balancing Criteria
        iii. Long-term effectiveness and permanence
        iv. Reduction of toxicity, mobility, and volume through treatment
        v. Short-term effectiveness
        vi. Implementability
        vii. Cost
    c. Modifying Criteria
        viii. State/Support agency acceptance
        ix. Community acceptance

The detailed evaluation of alternatives will be summarized in a final RAS report. It is envisioned that a preferred alternative or combination of alternatives will be identified based on the detailed individual and comparative evaluations.

7.0 POTENTIAL REMEDIAL TECHNOLOGIES AND ALTERNATIVES

To assist the RAS planning process, a preliminary identification of groundwater remedial technologies and remedial alternatives was performed during preparation of this work plan. The intent of preliminarily identifying remedial technologies and alternatives at this time is twofold: 1) focus the Groundwater RAS on commonly applied and effective technologies and 2) streamline the Groundwater RAS by avoiding unnecessary evaluation of technologies and alternatives simply for the purpose of administrative completeness. Emerging and innovative technologies may be identified and evaluated later in the Groundwater RAS process if deemed appropriate to meet RAOs and cleanup goals, or comply with ARARs.

The preliminary identification of remedial technologies and assembly of remedial alternatives were performed assuming that the general response actions for the site would be hydraulic containment of impacted groundwater and subsequent treatment to achieve the following preliminary RAOs:

- Protect human health and the environment from exposure to SRCs in groundwater, and
- Prevent degradation of groundwater quality by SRCs downgradient of the GWTS.

These preliminary RAOs may be refined, modified, or expanded during the Groundwater RAS.

7.1 POTENTIAL REMEDIAL TECHNOLOGIES

The following table includes commonly applied groundwater remedial technologies that could be implemented at the site as part of the long-term groundwater remedy.

Technology	Rationale and Discussion
No Action	Required by the National Contingency Plan (NCP)
Institutional Controls Property controls (e.g., deed restrictions, government controls, etc.) used to restrict, regulate, or limit access to impacted groundwater.	Necessary to maintain land use restrictions; some institutional controls are in place at the site.
Monitoring Short- and long-term groundwater monitoring to evaluate the nature, extent, and migration of contaminants.	Necessary to evaluate the effectiveness of active and passive groundwater remedies.
Monitored Natural Attenuation Regularly monitor groundwater to assess the degradation of SRCs by naturally occurring microorganisms and attenuation by dispersion	MNA may be an element of the overall groundwater remedy to address groundwater impacted by dilute dissolved-phase SRCs. MNA is a candidate remedy to address SRC-impacted groundwater downgradient of the GWTS.
Containment Prevent further migration of SRCs from source areas using extraction wells, injection wells, reactive barriers, and/or physical barriers.	Potentially applicable for source areas, DNAPL impacted area, and leading edges of SRC-impacted groundwater. Containment via “pump and treat” is the presumptive remedy at groundwater contamination sites (EPA, 1996).
In-Situ Treatment Destroy SRCs in groundwater in place using physical, chemical, or biological processes.	May be effective for relatively small-scale source area treatment for certain SRCs and possibly the DNAPL impacted zone.

Technology	Rationale and Discussion
Ex-Situ Treatment Remove or destroy SRCs from extracted groundwater using above-ground physical, chemical, or biological processes.	Currently performed at the GWTS; a combination of treatment technologies are employed to treat the broad range of SRCs in groundwater; discharge limits for treated water are needed to select appropriate treatment technologies.
Discharge of Treated Water	Required for pump and treat remedies; discharge options include Public Owned Treatment Works, surface water, and groundwater; treated water discharge will require approved permits

7.2 POTENTIAL REMEDIAL ALTERNATIVES

The following table includes a preliminary assemblage of potential remedial alternatives based on the preliminary list of technologies and preliminary RAOs. Groundwater remedial alternatives will be further developed and refined after the data gaps are resolved. Some of the identified technologies are not assembled into a remedial alternative at this time. However, these additional technologies are considered applicable to site conditions and could be used in the future. A combination of alternatives may be recommended as the overall site-wide groundwater remedy.

Alternative	Discussion
GW1: No Action	Required by the NCP and provides a basis for evaluation active remedies.
GW2: Institutional controls and groundwater monitoring	Limits human exposure by way of land and groundwater use restrictions; monitoring performed to track changes in plume, identify emerging threats to human health or the environment, and evaluate areas of further groundwater degradation.

Alternative	Discussion
GW3: Operate existing GWTS (ex-situ treatment and treated water discharge to groundwater) and MNA in downgradient area	Limits SRC migration in the mid-plume area; removes SRCs from groundwater; SRCs in the downgradient area would naturally attenuate over the long-term.
GW4: Operate enhanced GWTS and MNA in downgradient area	Limits SRC migration in the mid-plume area; enhancements may improve capture effectiveness of GWTS; removes SRCs from groundwater; SRCs in the downgradient area would naturally attenuate over the long-term.
GW5: Operate existing GWTS; contain DNAPL impacted area; and MNA in downgradient area	Limits SRC migration in the mid-plume area; removes SRCs from groundwater; limits contribution of dissolved-phase SRCs from DNAPL impacted area; SRCs in the downgradient area would naturally attenuate over the long-term.
GW6: Operate enhanced GWTS; contain DNAPL impacted area; and MNA in downgradient area	Limits SRC migration in the mid-plume area; enhancements may improve capture effectiveness of GWTS; removes SRCs from groundwater; limits contribution of dissolved-phase SRCs from DNAPL impacted area; SRCs in the downgradient area would naturally attenuate over the long-term.
GW7: Operate existing GWTS; contain source areas and DNAPL impacted area; and MNA in downgradient area	Limits SRC migration in the mid-plume area; removes SRCs from groundwater; limits contribution of dissolved-phase SRCs from all source areas; SRCs in the downgradient area would naturally attenuate over the long-term.
GW8: Operate enhanced GWTS; contain source areas and DNAPL impacted area; and MNA in downgradient area	Limits SRC migration in the mid-plume area; enhancements may improve capture effectiveness of GWTS; removes SRCs from groundwater; limits contribution of dissolved-phase SRCs from all source areas; SRCs in the downgradient area would naturally attenuate over the long-term.

A range of potential enhancements to the GWTS (e.g., physical barriers, reactive barriers, etc.) to improve its capture effectiveness and treatment performance would be identified and evaluated during the groundwater RAS. Treated water discharge will be an element of all of the active remedies listed above (GW3 through GW8). Further evaluation of treated water discharge options will be performed in the Groundwater RAS to select the best option, or combination of options, that complements the selected remedy and aids in achieving the RAOs and complying with ARARs.

8.0 GROUNDWATER REMEDIAL ALTERNATIVES STUDY SCHEDULE

A tentative schedule was developed for the Groundwater RAS (Figure 3). To the extent possible and appropriate, the resolution of data gaps and the preliminary screening of remedial technologies and alternatives will be completed concurrently. The schedule for the field work planned to address the data gaps depends on obtaining access to property owned by others. For the purpose of this work plan, it was assumed that access to the properties required for the field investigations will be obtained by August 1, 2008. Based on the current project status, field work designed to resolve data gaps is anticipated to continue into 2009.

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